An integrated framework for assessing community resilience in disaster management

Melissa M Teo[1], Ashantha Goonetilleke [2] and Abdul M Ziyath[3]

[1]Science and Engineering Faculty, Queensland University of Technology,
Melissa.teo@qut.edu.au
[2]Science and Engineering Faculty, Queensland University of Technology,
a.goonetilleke@qut.edu.au
[3]Department of Chemical and Process Engineering, University of Peradeniya
ammziadh@gmail.com

Climate change is predicted to increase the frequency and severity of extreme weather events which pose significant challenges to the ability of government and other relief agencies to plan for, cope with and respond to disasters. Consequently, it is important that communities in climate sensitive and potential disaster prone areas strengthen their resilience to natural disasters in order to expeditiously recover from potential disruptions and damage caused by disasters. Building self reliance and, particularly in the immediate aftermath of a disaster, can facilitate short-term and long-term community recovery. To build stronger and more resilient communities, it is essential to have a better understanding of their current resilience capabilities by assessing areas of strength, risks and vulnerabilities so that their strengths can be enhanced and the risks and vulnerability can be appropriately addressed and mitigated through capacity building programs. While a number of conceptual frameworks currently exist to assess the resilience level of communities to disasters, they have tended to differ on their emphasis, scope and definition of what constitutes community resilience and how community resilience can be most effectively and accurately assessed. These limitations are attributed to the common approach of viewing community resilience through a mono-disciplinary lens. To overcome this, this paper proposes an integrated conceptual framework that takes into account the complex interplay of environmental, social, governance, infrastructure and economic attributes associated with community resilience. The framework can be operationalised using a range of resilience indicators to suit the nature of a disaster and the specific characteristics of a study region.

Key Words : *disaster resilience, resilience framework, adaptive capacity, vulnerability, community*

1. INTRODUCTION

Natural disaster preparedness continues to feature prominently in local, state and national planning and management agendas as climate change continues to increase the frequency and severity of natural disasters experienced all around the world. For example, over the past 30 years in Australia, natural disasters have affected 16 million people, caused US$28 billion dollar worth of damage and killed close to a thousand people[1)]. Underpinning this trend of economic loss and human casualty is a realisation that our communities are not well-prepared for the challenges of surviving and recovering from natural disasters.

Building strong, healthy and resilient communities capable of withstanding and recovering from natural disasters is the most effective way to safeguard a community's future. To do so requires an understanding of the resilient characteristics of a community, and to identify areas of strength and weaknesses to facilitate communities as they prepare to cope and respond to natural disasters. While a number of frameworks exist to assess community resilience, these studies have tended to differ through their emphasis, scope and definition of what constitutes community resilience and how community resilience can be most effectively and accurately assessed[2) 3)]. These limitations are attributed to the common approach of viewing community resilience through a mono-disciplinary lens. Current frameworks are therefore inadequate as community resilience is multi-faceted and needs to consider important attributes related to ecological, economic, infrastructural, institutional and socio-cultural dimensions that make up a community[13)]. To overcome this, an

integrated conceptual framework that takes into account the complex interplay of ecological, economic, infrastructure, institutional and socio-cultural attributes associated with community resilience is proposed. It is however, not the aim of this research to develop a metric that can serve as a report card on a community's state of preparedness and resilience nature as it can lead to a sense of complacency and would be misleading as it would not account for the non-static nature of systems and people as part of the reporting process. Instead, it is the aim of the paper to explore the interactions between the key thematic areas and better understand the challenges associated with their usage in community resilience investigations.

2. DEFINING COMMUNITY RESILIENCE

Resilience as a concept has its origins in ecology, and is typically associated with the ability of an ecosystem to bounce back, absorb changes and still persist over time[4) 5)]. Its use in a hazard or disaster context evolved out of the need to understand and manage the complex interrelationships between people and nature, and to develop methodologies to measure how well a system (e.g. a group of people, a community or society) can absorb, cope with and recover from a disaster[6) 7)]. A focus on resilience in a hazard or disaster context is particularly empowering as it encourages a positive focus on competence and adaptive behavior, and a metaphorical conquering of nature and bounce back of the human spirit post-disaster. In particular, community resilience has evolved as a popular concept in recent times to account for the complex interactions between the built, natural and social environments and how they influence the way disasters are understood and should be planned for and dealt with[5)]. Community is referred to in this research as a geographic- or location-specific sense of belonging or attachment to a place that arises from a commonality of social experiences or sense of familiarity among people who live, travel, or work in the area[8)]. Community resilience then, allows a dynamic, people-centric look at resilience in a disaster context and refers in the context of this research to "*the capacity or ability of a community to anticipate, prepare for, respond to, and recover quickly from the impacts of natural disasters*" [7)]. In this sense, an ability to minimize the effects or damage that a disaster may cause in a way that facilitates the recovery process are desirable attributes of a resilient community (solid line), as depicted in the hypothetical trajectory of two communities in Figure 1.

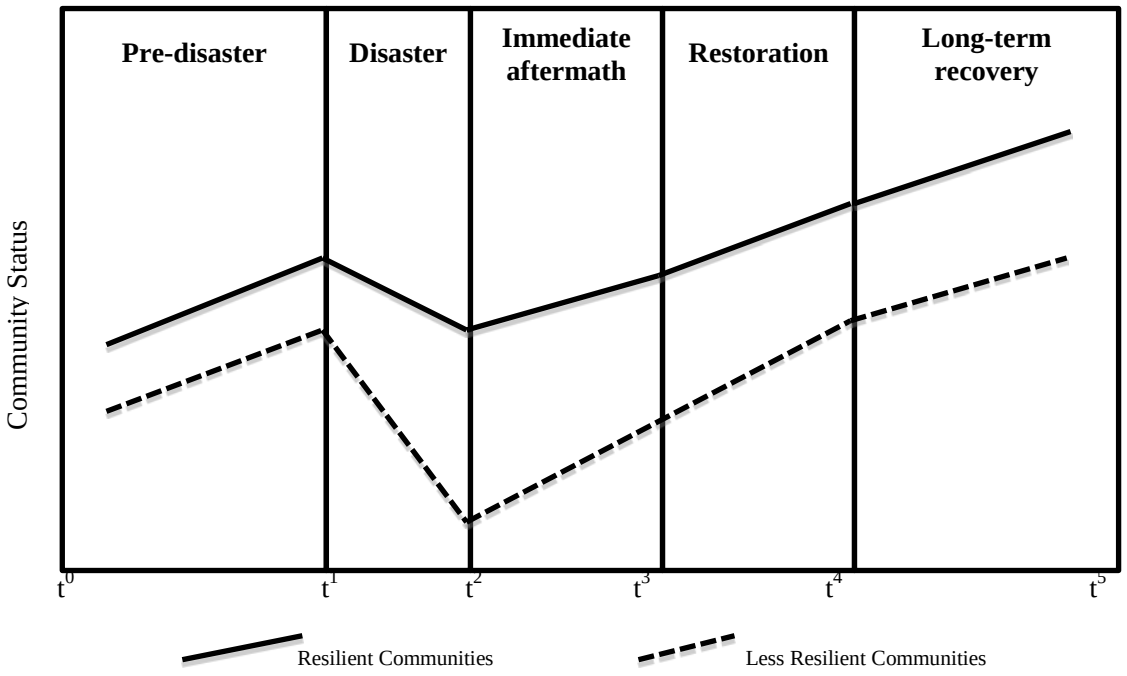

Fig. 1 – Hypothetical trajectory of resilient vs less resilient communities[7) 9)]

Figure 1 shows a marked difference in the proposed pathway to recovery that resilient vs less resilient community take. The hypothetical trajectory represents the sequential changes a community undergoes over five phases: pre-disaster preparation, when disaster strikes, the immediate aftermath, the process of restoration and long-term recovery[7) 9)]. As evident from Figure 1, resilient communities, through their improved state of preparedness, often experience reduced disaster impacts and damage than less resilient communities. This puts them in a better position to recovery more quickly from the immediate aftermath of the disaster, thereby aiding the long-term recovery of the community towards normality.

3. AN INTEGRATED FRAMEWORK FOR COMMUNITY RESILIENCE

Before proceeding to introduce the integrated framework for community resilience, it is important to acknowledge that a number of conceptual frameworks currently exist to assess the resilience level of communities to disasters. A point of distinction between them relate to their emphasis, scope and definition of what constitutes community resilience and how community resilience can be most effectively and accurately assessed[10) 11)]. For example, Cutter et el.[12)] identified a range of baseline indicators for measuring and monitoring disaster resilience of places. A total of thirty-six variables, derived from readily available secondary data sources, were distributed into the five resilience categories, namely: social, economic, institutional, infrastructure and community capital. A key limitation of the model relates to the deliberate design of the model to account for secondary data availability and the exclusion of ecological resilience from the model citing data inconsistency and variable relevancy. There are also specific frameworks that focus on particular disaster types. A key limitation of these frameworks is that they tend to view community resilience through a mono-disciplinary lens.

An integrated framework for community resilience that incorporates these attributes into a number of thematic and key areas is proposed. It consists of thematic areas, and its sub categories of key areas and resilience indicators as shown in Table 1. Community resilience is a complex concept involving various dimensions that make up a community. In broad terms, there is a general consensus in the literature that community resilience consists of five main areas[13)], which are referred to in the proposed framework as thematic areas. They are environmental, social, governance, infrastructure and economic resilience. Hence, the overall community resilience can be considered as the function of these five thematic areas:

Community resilience = f (environmental, social, governance, infrastructure & economic resilience)

The second layer of the framework are the key areas, which are derived by further partitioning each thematic area in order to comprehensively capture the characteristics of each thematic area for community resilience assessment. Table 1 presents an overview of the key areas which need to be determined by a multi-disciplinary panel of experts by considering factors such as local risks, vulnerabilities and the scale of the anticipated disaster. Additionally, the importance of each key area can also vary depending on these factors. Hence, an appropriate priority or weighting system can be assigned to determine their relative importance after taking into account location- and disaster-specific attributes. Finally, the primary variables that can encapsulate each key area need to be determined with the consensus of the expert panel before data collection. In selecting the variables, due care has been given to only include variables that are “relevant, robust and representative” [12)] as the quality of the variables have a direct relationship on the assessment process and its ability to paint a true picture of the state of a community’s resilience. There is however, enough robustness built into the design of the indicators to account for subjectivity considerations that are dependent on the context of the disaster and its associated attributes, as shown in Table 1.

Table 1 – Integrated conceptual framework for community resilience

Theme	Key Areas	Variables
Environmental	**Natural environment** (Location related characteristics which contribute to community survival and recovery)	• Local soil • Water • Land characteristics
	Built environment (Location relate characteristics that contribute to community survival and recovery)	• Protective measures • Geographical location
Social	**Demography** (Community profile/ characteristics that influence community resilience	• Age • Disability • Gender • Education • Wealth
	Social capital (Quality of relationships among individuals and at community level that contribute to community resilience)	• Bonding • Bridging • Linking
	Cultural characteristics (local, regional and national)	• Values • Beliefs • Expected behaviours • Roles and responsibilities
Governance	**Community policies and procedures** (robustness and comprehensiveness of government frameworks)	• Resource allocation and adequacy • Clarity of roles and responsibilities
	Planning (Ability of government to prepare communities to withstand/ overcome/ recover from disasters)	• Disaster preparedness
Infrastructure	**Individual mobility** (Ability of people to move to secure places and obtain essentials)	• Food • Water • Shelter • Health
	Community services (Robustness of essential services)	• Power • Water • Sewage • Communication
Economic	**Individual means of livelihood** (Ability of people to seek suitable employment)	• Availability of jobs to suit dignity • Availability of alternate employment
	Economic vitality of the community (Ability/ opportunity to revitalize/ reenergise the local economy)	• Diversity of industries

As shown in Table 1, there are five thematic areas that underpin the proposed model: Environmental, social, governance, infrastructure and economic. Collectively, the five thematic areas cover the essential functioning of a community during a disaster. A discussion of each thematic area, its associated key areas and variables is as follows:

Environmental

The first key thematic area, environmental, refers to the location related characteristics which contribute to community survival and recovery. Variables within this theme emerge from two different environments, namely the natural environment and the built environment. Linking variables from both environments allow for a consideration of possible interactions between the natural and built environments and their implications

for community resilience. For example, local land characteristics can impact on the type of houses that can be built in a disaster prone area e.g. building elevated houses or greater perimeter set-back in a flood prone area.

Social

Social resilience refers to the characteristics that underpin the physical, social and cultural composition of a community and its relationship with building naturally resilient communities. Collectively, variables within the key areas of demography, social capital and cultural characteristics provide an insight into the defining features or the 'heart' of a community and the extent that communities can tap into these attributes to make themselves more resilient in the event of a disaster. For example, on the basis of a community's demographic profile (age, disabled population, gender, education, wealth), it is possible to ascertain that communities with a high percentage of young working age male residents, with low proportions of disabled persons, highly educated and with high proportions of residents with vehicle ownership would exhibit greater resilience characteristics than those without the above characteristics[12)]. Similarly, an understanding of the amount of bonding, bridging and linking social capital that exist within the community allows an insight into the connectedness of the local community and the extent that they can harness these relationships in a positive manner when disaster strikes and to use it as a facilitative tool to aid post-disaster community recovery[14)]. The third key area, the cultural characteristics of an area e.g. local, regional or national, refers to locality-specific attributes or norms that underpin the way individuals and groups within a particular culture understand, prepare for and react to disasters[15)]. It is likely that the cultural characteristics will impact significantly on the state and nature of preparedness of disasters as it affects the manner in which disaster preparation are planned and executed within certain cultural domains.

Governance

The governance theme refers to the facilitative role of governments and associated institutions in aiding and building resilient communities. An understanding of governance needs to take into account the role and responsibilities assumed by various levels of the government (such as local, state and federal) and the extent that this impedes or facilitates community resilience. The first key area, community policies and procedures, refers to the robustness and comprehensiveness of government frameworks to plan for and mitigate the effects of natural disasters through clear definition and communication of policy, system and procedure and adequate provision of resources to empower and engage communities in building resilient communities[16)]. The second key area, planning, builds on the first key area, and is focused on the ability of government to prepare communities to withstand/ overcome/ recover from disasters.

Infrastructure

The infrastructure theme refers to the physical response capabilities of a community through an assessment of the health and capabilities of critical and vulnerable community infrastructure to withstand, respond and recover from a disaster. The first key area, individual mobility, refers to the ability of people to move to secure places and obtain essentials such as food, water, shelter, and to adequately sustain the community into the recovery process[12)]. The second key area, community services, refers to the robustness of essential life-sustaining services whose provision are beyond the control of the community but whose provision is essential to aid post-disaster recovery.

Economic

Economic resilience refers to the economic health and vitality of communities from two perspectives, namely the level of the individual and the community. On an individual level, the ability to seek equivalent or alternate employment can directly impact on the ability of communities to sustain themselves post-disaster. The availability and stability of the individual's livelihood will have a direct impact on post-disaster recovery of a community. At a community level, the ability or opportunity to revitalize or re-energise the local economy will depend on how diverse the economic base of a community is and is closely linked to individual means of livelihood[12)]. The state of economic health of a community can have long-term social and cultural effects where increased unemployment over extended periods of time creates sustained pressure on the community and a focus on short-term over long-term recovery.

4. METHOD

A case study approach is proposed to test the robustness of the integrated framework on community resilience. Suitable case studies include towns, suburbs or cities that have experienced a disaster situation in the last 5 to 10 years, both within Australia and overseas. Once potential case studies have been identified, desktop research will be conducted to build a community profile and used as the basis of questions in a series of in-depth interviews to be conducted with key community stakeholders to better understand the extent that communities perceive themselves to be resilient across the five identified thematic areas within the integrated framework of community resilience. Data collected from the interviews will be complemented by the use of surrogate indicators. An overview of the fundamental concepts related to surrogate indicators and the challenges associated with their usage in assessing community resilience is detailed in another paper currently in development by the authors.

5. CONCLUSIONS

Natural disasters are a reality for the communities and societies that they impact. Building strong, healthy and resilient communities capable of withstanding and recovering from natural disasters is the most effective way to safeguard a community's future. To do so requires an understanding of key attributes of the community that can facilitate or hinder community resilience and to identify the role that various stakeholders can play in the process. While a number of frameworks exist to better understand community resilience, these are limited by the common approach of viewing community resilience through a mono-disciplinary lens. An integrated framework of community resilience is proposed to address this deficiency. The framework accounts for the multi-faceted nature of community resilience concepts and the need to consider important attributes related to ecological, economic, infrastructural, institutional and socio-cultural dimensions that make up a community.

REFERENCES

1) UNISDR: Prevention Web, accessed 23 April 2013, http://www.preventionweb.net/english/countries/statistics/?cid=9
2) Ford, J.D. and Smit, B.: A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. *Arctic*, 57 (4), 389–400, 2004.
3) Chang, S.: Urban disaster recovery: a measurement framework and its application to the 1995 Kobe earthquake. *Disasters*, 34 (2), 303–327, 2010.
4) Holling, C.S.: Resilience and stability of ecological systems, *Annual Review of Ecology and Systematics*, 4, 2-23, 1973.
5) Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F. and Pfefferbaum, R. L.: Community resilience as a metaphor, theory, set of capacities and strategy for disaster readiness, *American Journal of Community Psychology*, 41, 127-150, 2008.
6) Klein, R.J.T., Nicholls, R.J. and Thomalla, F.: Resilience to natural hazards: How useful is this concept?, *Environmental Hazards*, 5:1, 35-45, 2003.
7) Mayunga, J.S.: Understanding and applying the concept of community disaster resilience: A capital-based approach, draft paper prepared for the *Summer Academy for Social Vulnerability and Resilience Building*, 22-28 July 2007, Munich, Germany.
8) Cater, J. and Jones, T.: *Social geography: An introduction to contemporary issues*, London & New York: Edward Arnold, 1989.
9) Zhang, Y.: Modeling single family housing recovery after hurricane Andrew in Miami-Dade County, Florida. A PhD dissertation, College Station, TX: Texas A&M University, 2006.
10) Chang, S.E. and Shinozuka, M.: Measuring and improving the disaster resilience of communities, *Earthquake Spectra*, 20 (3), 739-755, 2004.
11) Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. and Webb, J.: A place-based model for understanding community resilience to natural disasters, *Global Environmental Change*, 18, 598-606, 2008.
12) Cutter, S.L., Burton, C.G. and Emrich, C.T.: Disaster resilience indicators for benchmarking baseline conditions, *Journal of Homeland Security and Emergency Management*, 7 (1), 1-22, 2010.
13) Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W., and von Winterfeldt, D.,: A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra*, 19(4), pp.733–752, 2003.
14) Colclough, G. and Sitaraman, B.: Community and social capital: What is the difference?", *Sociological Inquiry*, 75 (4), 474-496.
15) Hofstede, G.: Culture's consequences: *Comparing values, behaviours, institutions and organisations across nations*, Sage, 2001.
16) Joerin, J. and Shaw, R.: "Chapter 3: mapping climate disaster and disaster resilience in cities", in Shaw, R. and Sharma A. (eds)., Climate and disaster resilience in cities (Community, Environment and Disaster Risk Management, Volume 6), Emerald Group Publishing, 47-61, 2011.